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How to take advantage of tablet computers: Effects of news structure on recall and comprehension

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Abstract: In light of the growing use of tablets for news reading and mobile news consumption behaviors, this study examined whether an innovative way of structuring news on the tablet that mimics mobile news behaviors reinforced attention for, and learning from, news. Specifically, it was theorized that the chronological and associative structuring of news articles into so-called developing news stories would lead to more attention for news, and better recall and comprehension of news, than the linear print newspaper structure that newspaper publishers continue to copy from print to tablet. A multiple-day experiment was set up using the eye-tracking method to measure and control for attention. The results show that the developing news structure increased comprehension of news substantively, independently of attention effects; no effects were found on attention and factual recall.

Keywords: attention, news comprehension, news recall, information structure, information processing, tablet computer

1 Introduction

Since its introduction at the beginning of 2010, the Apple iPad tablet computer has become one of the most quickly adopted consumer goods of the recent era (Pew Research Center 2011a). This success has paved the way for competitors to further expand the tablet market. Within the next years, media tablets are predicted to become the primary computing device, with worldwide tablet sales estimates rising from 56 million in 2011 to 375 million in 2016 (Forrester Re-

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search 2012a). To put these numbers in perspective: As of 2016, one in three American adults is expected to own a tablet of some sort (Forrester Research 2012b). When we look at the Flemish market, the focus of this study, we see an increase in tablet ownership from 13 % in 2012 to 41 % in 2013 (iMinds 2013).

News consumption ranks as one of the most prominent functions of the tablet. Since 2011, over half (53 %) of US tablet users have been getting news on their tablet daily; of those users who consume news on their tablet at least once a week (77 % of all tablet users), fully 90 percent say news on the tablet has become a replacement for news they previously accessed in other ways (Pew Research Center 2011b). In addition, the Digital News Report 2014 from the Reuters Institute for the Study of Journalism (2014) provides evidence for the growth in tablet access for news in Europe, with the percentage of people saying they used a tablet to access news during the week prior to the survey rising from 12 % (2012) to 34 % (2014) in Denmark, from 8 % (2012) to 23 % (2014) in the UK, from 6 % (2012) to 18 % (2014) in France, and from 6 % (2012) to 15 % (2014) in Germany. Altogether, these data suggest the tablet has the potential to become a mainstream news platform in the near future.

Publishers of print newspapers embrace the tablet as a welcome turning point for the downward trend in readership and advertising revenues. Whereas the transition from print to online news is characterized by an ongoing search for sustainable business models (Mitchelstein and Boczkowski 2009), targeted software applications (apps) that use the internet for transport but have a distinctive browser provide the print industry with a platform for meeting today's news users' needs more successfully. Since mobile devices have further extended news consumption beyond boundaries of time, place, and daily routines, news behaviors are increasingly shaped by the need to follow up news on a more continuous basis. Indeed, recent studies indicate that mobile platforms are experienced as principally useful for having easier access to news throughout the day (Dimmick, Feaster, and Hoplamazian 2010; Pew Research Center 2012), enabling users to keep track of news stories of particular interest (Pew Research Center 2011b). For example, Van Cauwenberge, d'Haenens and Beentjes (2013) found that, in particular, users of mobile platforms consume news as chronological, continuing stories in which new elements and developments are continuously being tracked and integrated.

News apps meet these emerging mobile news behaviors by providing immediate and easy access to news brands on closed platforms, a service which is preferred to flexible web search and link strategies typical of traditional internet browsers (Pew Research Center 2012). In addition, the app architecture provides an environment for the implementation of presentation modes that tap

into the continuous news consumption processes of mobile users, to the extent that the processing of news stories might be facilitated.

The aim of the present study is to examine the effect of an innovative way of structuring news on the tablet that mimics mobile news behaviors on attention and public affairs knowledge acquisition. Previous news learning research suggests information structure is a prominent variable in explaining differential public affairs knowledge acquisition. Based on this line of research and insights from cognitive psychology, we present a news structure that is expected to increase attention for news and facilitate recall and comprehension of news through the presentation of news articles in chronologically and associatively structured *developing news stories*. By means of a multiple-day eye-tracking experiment this study will analyze whether the presented news design improves attention for, and knowledge of, news compared to the linear print newspaper structure that newspaper publishers continue to copy with no or little alteration from print to tablet.

The contribution of our study is twofold. Theoretically, our study aims at contributing new insights to the current understanding of how people learn from the news by shedding light on new and so far unexamined information structures that mirror the distinctive news consumption and information processing behaviors of an increasingly mobile news audience. From a practical point of view, we present a design for structuring news on the tablet that tailors mobile news behaviors, and takes into account the spatiotemporal and technological characteristics of the tablet medium. We believe publishers of print papers, who traditionally tend to be somewhat hesitative of innovation (Mitchelstein and Boczkowski 2009), have opportunities here for meeting today's news users' expectations with more success.

2 Effects of associative and chronological news structures on recall and comprehension

Experimental studies that examined effects of news structure on knowledge acquisition mainly compared learning from media that structure news linearly (i.e., print newspapers, linear web designs) and media that structure news associatively through hyperlinks (i.e. non-linear web designs) (e.g., Eveland, Cortese, Park, and Dunwoody 2004; Eveland and Dunwoody 2001, 2002; Eveland, Marton, and Seo; 2004; Eveland, Seo, and Marton 2002; Lowrey and Kim 2009; Yang and Grabe 2011).

The linear news structure is defined as a way of organizing news articles so that users are encouraged to follow the fixed ordering of articles when going through the news. For example, traditional print papers are designed to be read from front to cover, although different reading patterns may occur. In addition, whereas hypermedia structure news articles associatively through linkages with thematically related and previously covered news articles, the linear structure is more rigid in that it presents news as stand-alone stories without the integrated contextual framework typical of hypermedia structures.

This strand of research made a distinction between two distinct learning outcomes which involve different cognitive capacities: remembering and understanding (Findahl and Höijer 1985; Ortony 1978; Woodall, Davis, and Sahin 1983). Remembering refers to the cognitive processes by which information is simply stored in, and retrieved from, memory (i.e., episodic memory), whereas understanding relates to the cognitive elaboration processes whereby new information is meaningfully linked with previous knowledge through associations and inferences (i.e., semantic memory) (Craik 2002; Ortony 1978). Thus, what people remember from the news reflects their ability to retrieve a specific news story from memory, while understanding involves the extent to which people capture the meaning of a news story and can relate this information to other knowledge.

The selection of measures that are sensitive to a specific type of learning under study is a fundamental criterion for tapping these differentiated cognitive processes (Brosius 1989; Findhal and Höijer 1985; Woodall et al. 1983). The remembering of news is measured by such measures as free recall, recognition and factual recall that assess memory for discrete information. Assessing what people understand from the news, on the other hand, requires measures that capture how people make sense of information and integrate information meaningfully into their existing knowledge representations; for example, the ability to link associated bits of information, measured with *Structure of Knowledge* or *Knowledge Structure Density* (Eveland, Cortese et al. 2004; Eveland, Marton et al. 2004).

The body of research that compared learning from linear versus non-linear (hypermedia) information structures argued that hyperlinked web designs encourage meaningful information processing because hyperlinks facilitate the making of mental associations between related bits of information (Jonassen 1991). Given that both human memory and hypermedia are organized by association (Jonassen and Wang 1993), it has been hypothesized that *associative*, hyperlinked web designs should lead to better *news comprehension*, compared to linear news structures.

In sum, findings from this line of inquiry indicated that hyperlinked web structures have some advantage over linear designs for meaningful learning because of their associative linking structure (Eveland, Cortese et al. 2004; Eveland, Marton et al. 2004; Eveland, Seo et al. 2002), whereas linear designs were found to increase recognition (Eveland and Dunwoody 2001) or remembering of facts (Eveland, Cortese et al. 2004; Eveland, Marton et al. 2004; Eveland, Seo et al. 2002). However, other studies provided no evidence consistent with the claim that hyperlinked structures enhance comprehension (Lowrey and Kim 2009; Yang and Grabe 2011).

Analyses of the underlying processes that mediate information processing provide some explanations for these mixed findings. First, hyperlinks, although stimulating elaboration through associative linkages, cause selective scanning of information and an overall decrease in factual learning (Eveland and Dunwoody 2002). In addition, it was reported that users spend a substantial amount of their cognitive capacities orienting themselves to the hyperlinked web structure, which comes at the expense of meaningful cognitive elaboration (Eveland and Dunwoody 2000).

In sum, the findings from this line of research indicated that hyperlinked web structures have some advantage over linear designs for meaningful learning because of their associative linking structure, but, on the other hand, hypermedia lack efficiency due to the somewhat loose and chaotic make-up. Nelson and Palumbo (1992), for example, noted that, contrary to human memory, hypermedia do not specify the nature of linkages between bits of information. Therefore, it seems plausible that users of hyperlinked web designs have to invest additional cognitive effort to understand how different bits of information are related to each other.

Besides analyzing the effect of associative news structures for news comprehension, some studies have examined whether the *chronological structuring* of news increased *news recall* (Wise, Bolls, Myers, and Sternadori 2009; Lang 1989; Lang, Potter, and Grabe 2003; Machill, Köhler, and Waldhauser 2007). It is reasoned that the temporal order of news stories mirrors the manner in which events are processed cognitively. Information about experienced events is stored in unique episodic memory traces. Such information includes specific characteristics of an event, spatiotemporal and situational details, as well as the temporal order of activity within the event (Tulving 1972, 2002). Woodall and colleagues (1983) noted that contextual cues, such as temporal order, that are stored as part of the episodic memory trace, may serve as effective retrieval cues for news recall.

Most research has examined effects of a chronological news structure with other characteristics of narrative journalism (for a discussion of narrative jour-

nalism, see Machill et al. 2007; Neveu 2014), which makes it difficult to distinguish effects of temporal order from effects of other storytelling characteristics (e.g., Lang et al. 2003; Machill et al. 2007; Wise et al. 2009). A notable exception is a study by Lang (1989), which found that television news stories that are written in a chronological order (i.e., cause-change-consequences) are better remembered than stories presented in the typical broadcast style (i.e., newsworthy facts first – who, when, where, what – followed by details and background information). The findings provided proof for the assumption that news stories are experienced as events with episodic memory traces in which contextual cues such as the chronological order of information facilitate remembering of news.

3 The developing news story structure

Taking into account both strengths and weaknesses of the associative and chronological news structures for learning, this study presents an innovative way of structuring news on the tablet, the so-called *developing news story structure*, as developed and produced by AxzMedia. We will describe the developing news story structure with more detail in the method section, but for the sake of constructing our hypotheses the main lines are presented here.

First, we follow Lang's argument that a style of writing and presentation that maximizes the chronological nature of news might be of great importance for reinforcing people's ability to recall news (Lang 1989). It is argued that a chronological, temporal order of news stories mirrors the manner in which events are stored in memory, and, therefore, facilitates news recall (Woodall et al. 1983). Following these premises, we suggest in this study a news structure in which related news articles are presented and stored chronologically within the framework of a *developing news story* (see Figure 1). Instead of implementing a chronological temporal order *within* a news story (which would require journalists to adopt a more narrative writing style instead of the classic inverted pyramid style), we propose to apply a chronological order *between* news articles by depicting news articles on a timeline, so as to foster the creation of a narrative between news articles over time. This organization fits well with the chronological, temporal order in which events are stored episodically in human memory, and the way in which news stories are experienced and followed up on by mobile news users. Following Lang's (1989) study, which found that television news stories that were written in a chronological order were better remembered than stories presented in the typical broadcast style. We hypothe-

size that the developing news story structure will lead to better recall of news content than a linear print structure (see Figure 2).

[H1] A developing news story structure leads to better recall of news content than a linear structure.

In addition, it is expected that the chronological structure of related news articles within developing news stories will increase attention for those news articles in terms of time spent reading the articles. We argue that the developing news story structure will increase attention for news by stimulating users to experience and process news articles as developing stories which they want to follow up on. Previous research, indeed, indicated that individuals who track news stories on a more continuous, chronological basis throughout the day, experience news as evolving stories which are followed up on to track changes and developments (Van Cauwenberge et al. 2013). Hence, the following hypothesis was formulated.

[H2] A developing news structure leads to more attention to news than a linear news structure.

Finally, studies have indicated that an associative news structure (e.g., hyperlinks) enhances cognitive elaboration and news comprehension (Eveland, Cortese et al. 2004; Eveland, Marton et al. 2004; Eveland, Seo et al. 2002). However, hypermedia were found to have some negative by-products such as disorientation and cognitive load (Eveland and Dunwoody 2000). Therefore, instead of using hyperlinks as a means to structure news associatively, the developing news story structure organizes information associatively by integrating and presenting thematically related news articles within the same developing news story, so as to reinforce the interrelated nature of information within a specific news domain. Doing so, the developing news story framework serves as a context for making sense of newly encountered news information and facilitates the cognitive elaboration of news in relation to other relevant news articles.

The associative structuring of information within a framework reflects how individuals cognitively process and store information. Schema theories of memory posit that knowledge is semantically organized and stored in mental information frameworks or schemas, which store knowledge about specific topics, events, people, etc. (Schank and Abelson 1977; Rumelhart and Ortony 1977). These schemas serve as contexts for making sense of information (e.g., Crocker, Fiske, and Taylor 1984). Based on previous findings from Eveland and col-

Figure 1: Example of the developing news story structure (Kuew-app, AxzMedia).

leagues (2002, 2004a, 2004b) and insights from schema theories, we expect that the associative structuring of thematically related news articles within developing news stories will provide users with a context that facilitates comprehension of news. The following prediction was made.

[H3] A developing news story structure leads to better comprehension of news content than a linear structure.

4 Method

4.1 Participants

Twenty-four participants were recruited from communication courses at the University of Leuven in the winter of 2011. The students received two movie

tickets for their participation. Approximately 33 % of the participants were undergraduate students and 67 % were graduate students. The average age of the participants was 22 (SD = 2.45), and two out of three participants in the study were women. A quarter of the participants reported using news on mobile platforms (defined as cell phones, PDAs and tablets).

4.2 Design

The study conducted a three-day eye-tracking experiment during which participants were each day exposed to natural news content of the day's news. Two conditions were employed: linear structure versus developing news story structure. Participants were randomly assigned to one of the two conditions. There were no significant differences in socio-demographic characteristics between the two conditions. In addition, no significant differences were found between the two conditions for interest in public affairs news, prior knowledge of public affairs news, and time spent on news the week prior to the experiment. The eye-tracker could not be calibrated for two participants, and on the second day of the experiment one person dropped out. These three participants were excluded from further analysis, leaving nine participants in the linear condition and twelve participants in the developing news story condition.

Medium (iPad) and news content were identical in both conditions. Furthermore, the design had a number of advantages with specific relevance for testing our hypotheses. Conducting an experiment across three consecutive days allowed participants to track and process news stories over time. This procedure is more reflective of the cumulative way in which users process news in real life. In addition, the timespan enabled the naturally occurring flow and development of news stories, which was a fundamental requirement for detecting possible effects of the developing news story structure. Natural news content was employed in order to reinforce ecological validity. This made it possible for participants to keep tracking specific news themes of interest during the experiment, making use of pre-existing knowledge for the interpretation and integration of new stories. The target news topic in this study was the forming of the Belgian government. This target topic was chosen because we expected interest in news articles concerning this matter would be high. The process of building a Belgian government was extensively covered in the news during the week prior to the experiment as negotiation rounds entered the final stage.

In order to measure attention, we employed eye-tracking equipment. Previous experimental media effects research indicated the importance of measuring

and controlling for attention when evaluating the results of a news learning study, so as to enable the distinction between effects of attention for news and effects of medium manipulation (Eveland et al. 2002). Implicit, online measures are preferred for assessing mental processes that take place below the threshold of awareness, instead of offline self-report measures (Geiger and Newhagen 1993). Eye-tracking measures have proven to be reliable measures of ongoing perceptual encoding processes, such as the allocation of visual attention during learning (Mayer 2010). Eye-tracking provides unique information about what stimuli are visually attended to and for how long (Van Gog and Scheiter 2010). In this study, we employed total fixation time as a measure of attention to news. Total fixation time serves as a useful index for encoding and attentional processes carried out during the learning phase (Hyönä 2010).

4.3 Procedure

Participants were asked to sign up for time slots for each of the three consecutive days of the experiment. The students that signed up for the experiment were asked to restrict their news exposure to the news they received in the experimental condition. Upon arrival on the first day, each participant filled out a short pre-test questionnaire. Afterwards, participants were randomly assigned to one of the two conditions. The procedure was identical for both conditions.

Participants were asked to sit in front of the iPad. The iPad was placed in an upright position so that the remote eye-tracker, which was set up in an inverted position just above the iPad, could unobtrusively track the eyes of the participant. The seat was adjustable so that participants could find a comfortable reading position. Participants sat approximately 60 cm from the screen. A small scene camera, attached to the side of the table, filmed the iPad screen during the eye-tracking session. The scene camera was connected with the eye-tracker so that eye gaze records were simultaneously mapped onto the camera records. The eye-tracker was connected to two computers. One computer was located in the eye-tracking lab for the calibration procedure. The second computer was located in an observation room next to the eye-tracking lab, which allowed the researcher to follow the participants' interactions without distracting them during testing.

After participants were installed and taken through the calibration procedure, the researcher briefly introduced the design and functions of the news application. For example, participants were informed how the news articles were organized, how to go from one article to the other, how to enlarge pic-

tures, and so forth. Participants received the instruction to "read and go through the articles during the next fifteen minutes as you would normally do". The researcher followed the eye-tracking session in the observation room next to the eye-tracking lab. This procedure was repeated on the second day of the experiment. Participants were again reminded to not follow any news outside the experimental condition. After the eye-tracking session on the third day of the experiment, participants completed a post-test questionnaire. Afterwards, participants got a debriefing about the nature of the experiment and received two movie tickets for their participation.

4.4 Stimulus materials

In the linear condition, participants were exposed to the tablet edition of the Flemish print quality newspaper *De Standaard* (see Figure 2). A shortened version of the tablet edition was created for this experiment. The shortened version contained a maximum of ten articles per day. The limitation in articles increased the likelihood that participants would actually read all the articles which they were exposed to in the experiment. The design was linear in that the only way to move between articles was by using the touchscreen to scroll from left to right through the news articles, or by touching the page arrows at the bottom of the screen. Apart from some differences in lay-out, the overall structure of the tablet edition overlapped largely with that of the print edition. One notable difference with the print version was that pictures and graphs in the tablet version could be enlarged by touching the screen. Also, each page contained a maximum of two articles, presented next to each other. To read an article entirely, people had to switch to the second half of the page by scrolling down. Cues on top of each page served as indicators of the news categories that were dealt with on a specific page (for example, "front page", "home affairs", "sports"). The ordering of the articles was as follows: prominent news stories first, followed by home affairs and national politics, international affairs, economy, and, finally, sports. The article lay-out (i.e., headline size, font, article length, visuals) was identical to the print version.

The second condition consisted of a news app (*Kuew*-app) that structured news into so-called developing news stories (see Figure 1). This news application was developed and produced by AxzMedia. All news articles in the application were stored and displayed chronologically, in order of appearance, over time on a timeline at the bottom of the screen, with the most recent articles on the left side. Because in the experiment news articles were entered each day simultaneously into the application, the order of appearance depended on the

Figure 2: Example of the linear news structure (De Standaard-app).

day on which articles were submitted. Admittedly, this was a less fine-grained temporal ordering than would have been the case when using the application online in real time. The ordering of the articles within a given day was identical to the ordering of the articles in the linear condition. An important difference between the two conditions, however, is that the application in the linear condition only displayed news articles of the day concerned, whereas the application in the developing news story condition stored news articles over the three consecutive days of the experiment. The timeline at the bottom of the screen can thus be thought of as a news archive which stored all news articles across the three consecutive days of the experiment. Each news article on the timeline was depicted by a visual (a minimalized representation of the visual that accompanied the actual article) with underneath a tag representing the name of the developing news story it belonged to. For example, all news articles about the Belgian government formation were tagged with 'Di Rupo I' (i.e., the first cabinet named after the Belgian Prime Minister). Each article belonged to a developing news story, although not all news stories were covered across the three consecutive days of the experiment. Participants were able to browse

through the articles on the timeline by scrolling sideways. When selecting an article in the timeline, the framework of the corresponding developing news story opened in the center of the screen.

The framework of the developing news story consisted of three structural elements. At the top of the framework, a bar contained all news articles which had appeared over a period of time within a developing news story. The news articles were presented chronologically, in order of appearance, with the most recent ones on the left side. The depiction of articles in the bar was identical to the representation of the articles on the timeline at the bottom of the screen. Participants could browse through the news articles within a developing news story by scrolling sideways. A specific news article was accessed by either selecting the article in the news timeline at the bottom of the screen or by selecting the article in the bar within the developing news story framework. This action opened the selected news article in the central frame of the developing news story framework. The news article lay-out was stripped of typical attention-grabbing cues such as prominent headlines and in-text visuals. A bar at the bottom of the developing news story framework contained the accompanying visuals of the specific news article, in case there were any. To switch from text to visual, participants had to select the visual, which then opened in the center of the developing news story. To read an article entirely, people had to switch to the second half of the page by scrolling down.

The news content in the study consisted of actual news articles that appeared in the print edition of the Flemish newspaper *De Standaard* on the day of the experiment, respectively 6, 7, and 8 December 2011. On each of the three days of the experiment a web designer of the newspaper *De Standaard* uploaded a selection of ten news articles in the tablet applications of *De Standaard* and AxzMedia (*Kuew*-app). As mentioned earlier, the application of *De Standaard* only displayed news articles of the day concerned, whereas the *Kuew*-application stored news articles over the three consecutive days of the experiment. Thus, whereas in the linear condition articles were replaced by new material on day two and three of the experiment, in the developing news story condition new articles were added to the older articles already available in the application. The selection of articles included articles about news stories that ran over a period of time and were therefore expected to be covered during the three days of the experiment (these news stories were: the Belgian government formation, the disappearance of a Flemish student, the Eurocrisis), and articles about news stories that were only covered for one or two days (for example, the presentation of a Belgian cycling team, the capturing of an Italian mafia boss in Naples, the Congolese elections). A total of thirty news articles were included in the experiment. Most articles dealt with issues concerning the Bel-

gian government formation (n = 10), followed by the Eurocrisis (n = 7), home affairs (n = 6), international affairs (n = 5), and sports (n = 2).

4.5 Measures

Cued recall. A cued-recall test measured what participants remembered from the target topic. In the post-test questionnaire participants were asked to write down everything they could remember having read about the Belgian government formation during the three days of the experiment. There was no time limit. The cued-recall data were coded as the number of accurate facts, defined as discrete thoughts which participants could formulate about the target story (M = 7.81; SD = 4.65).

Knowledge Structure Density. Following Eveland et al. (Eveland, Cortese et al. 2004; Eveland, Marton et al. 2004), Knowledge Structure Density (KSD) served as a measure for assessing what participants understood from the news. More precisely, KSD measured the extent to which participants were able to connect concepts, events, and persons that were related to our target news story, the Belgian government formation. Participants were provided an empty 7×7 matrix, with seven concepts about the Belgian government formation spread across the first row and again down the first column. These concepts included persons, events and objects that were covered in the news articles about the Belgian government formation during the experiment. Participants were instructed to indicate to what extent concepts were related to each other (1 = very weakly related to 5 = very strongly related). If, according to participants, concepts were not related, a zero had to be placed in the cell matrix. Based on the values in the matrix, KSD was calculated for each participant, given the following formula:

$$\frac{\sum \mathrm{kv}}{\mathrm{n(n\text{-}1)/2}}$$

In this formula k represents a specific link between two concepts, v is the value (from 0 to 5) attached to the k^{th} link, and n is the total number of concepts in the matrix (in this case seven). The formula results in an outcome ranging from zero to five, with values reflecting the average level of interconnectedness of concepts in the matrix (M = 2.62, SD = 0.79). Because all concepts in the matrix were highly related to each other, a high KSD-value represented a high level of understanding of the news coverage concerning the Belgian government formation.

Eye fixation time (attention). Based on the eye-tracking data, two measures of attention were constructed: total eye fixation time and the total number of articles read about the Belgian government formation. First, total eye-fixation time was defined as the total time participants paid attention to news articles (text and illustrations) in the iPad application. Total fixation time was recorded using a Tobii x120 Eye Tracker, which is a remote eye-tracker that enables reliable recordings for studies with mobile devices. Afterwards, total fixation time was calculated for each news article separately using the Tobii Studio 2.2 software. Total eye fixation time for the target story was calculated by adding the total fixation times (measured in seconds) for all the news articles about the Belgian government formation (M = 791.34, SD = 151.78).

Number of articles read (attention). In addition to the total eye fixation time, a second measure of attention was derived from the eye-tracking data, namely, the total number of articles that participants had read about the Belgian government formation during the three days of the experiment. Replay of individual eye-tracking sessions with the gaze points of the test participant superimposed allowed the extent to which each article was read to be examined. When an article was read entirely, it was coded as 3, when an article was read partially it was coded as 2, and if not read or only briefly glanced over, the article would be coded as 1. The scores for all the articles concerning the Belgian government formation were averaged (M = 2.53, SD = 0.31). The range in variance was situated between the values 2.10 and 3.00, which indicates that all participants had read most articles about our target story at least partially.

Attention and the number of articles read were not significantly correlated (r = 0.26, p = .264).

Additional exposure. In the post-test we asked participants if they had followed news outside the experimental setting during the three days of the experiment with one yes-no question, coded as either 1 (yes) or 0 (no) (M = 0.67, SD = 0.48). We controlled for additional exposure in all analyses.

5 Results

To test hypotheses 1 and 3 of this study, two analyses with the General Linear Model were conducted: one analysis for cued recall and one analysis for KSD. Each analysis included the structure manipulation as a between-subjects factor, and attention (eye fixation time and number of articles read) and additional exposure as covariates.

Hypothesis 1 predicted that the developing news story structure would lead to better recall of news content than the linear structure. We examined the

Table 1: General linear model for cued recall.

	df	*F*	*p*	Partial η^2	η^2
Structure manipulation	1	0.75	.399	.045	.041
# Articles read	1	0.09	.765	.006	.005
Eye fixation time	1	1.23	.283	.071	.068
Additional exposure	1	0.06	.805	.004	.003
Error	16				

Note: R^2 = .106; adjusted R^2 = −.118

Table 2: General linear model for knowledge structure density.

	df	*F*	*p*	Partial η^2	η^2
Structure manipulation	1	5.05	.039	.240	.171
# Articles read	1	6.74	.020	.296	.229
Eye fixation time	1	1.34	.264	.077	.046
Additional exposure	1	0.32	.577	.020	.011
Error	16				

Note: R^2 = .398; adjusted R^2 = .247

effect of the experimental manipulation after controlling for eye fixation time, number of articles read, and additional exposure. Table 1 presents the results of this analysis. There was no statistically significant effect of the experimental manipulation on cued recall (p = .399). The mean values, adjusted for eye fixation time, number of articles read, and additional exposure, are presented in Table 3. Mean comparisons using the Sidak adjustment showed that cued recall in the developing news story structure was lower, although not significantly, than in the linear condition. Thus, Hypothesis 1 was not supported.

Hypothesis 3 predicted that the developing news story structure would lead to better understanding of news content than the linear structure. To test this hypothesis we examined the impact of the structure manipulation on KSD. The results of this analysis are displayed in Table 2. The structure manipulation had a statistically significant effect on KSD, after controlling for eye fixation time, number of articles read, and additional exposure, $F(1,16) = 5.05$; p = .039. The effect sizes show that this was a medium effect size difference between the conditions (η^2 = .171; η^2_{partial} = .240) (Levine and Hullett 2002). Mean comparisons with Sidak adjustment indicated that the developing news story structure lead to a significantly higher KSD-score (M = 3.09; SE = 0.30) than the linear

Table 3: Adjusted means for cued recall and knowledge structure density by condition.

	News structure			
	Linear		*Developing news story*	
	M	**SE**	**M**	**SE**
Cued recall	8.98[a]	1.73	6.93[a]	1.48
Knowledge structure density	2.10[a]	0.35	3.09[b]	0.30

Note: Cued recall and knowledge structure density mean values are adjusted for eye fixation time, number of articles read, and additional exposure. Mean values within a row with different superscripts differ significantly at $p < .05$.

news structure (M = 2.10; SE = 0.35) (see Table 3). Hence, Hypothesis 3 was confirmed.

Finally, we examined whether the developing news story structure led to more attention for news, compared to the linear news structure (Hypothesis 2). Two independent t-tests showed that, although both eye fixation time (M_{Linear} = 752.44; SD = 128.93; $M_{Developing}$ = 820.50; SD = 166.22) and number of articles read (M_{Linear} = 2.41; SD = 0.25; $M_{Developing}$ = 2.62; SD = 0.33) were higher in the developing news story condition, the differences with the linear news structure conditions were not significant ($t(19) = –1.018$, $p = .322$; $t(19) = –1.565$, $p = .134$, respectively). Hence, our findings did not confirm our second hypothesis.

6 Conclusion and discussion

The aim of this study was to examine whether an innovative way of structuring news on the tablet leads to an increase in attention for news, and recall and understanding of news, compared to a linear news structure. Our findings showed that it matters how tablet apps structure news. Most importantly, the developing news story structure led towards a substantive increase in news comprehension. Participants who learned from the developing news story structure were better at assessing how different bits of news information about our key story fitted together than participants who learned from the linear structure. The results are consistent with previous findings that associative hyperlink structures may be superior to linear structures for understanding the news (e.g., Eveland, Cortese et al. 2004; Eveland, Marton et al. 2004; Eveland, Seo et al. 2002), but extend these findings by focusing on a news structure that, instead of hyperlinks, uses a chronological and associative structuring of news articles within developing news stories as the organizing principle.

Despite these findings, the developing news story structure did not improve cued recall of news. Although it is rather difficult to explain why recall was unaffected by the developing news story structure, we suggest this finding might be attributed to differences in lay-out between the tested news applications, such as the vividness of display or the readability of the text. In contrast with the application of *De Standaard*, articles in the developing news story application lacked typical lay-out features that facilitate reading, such as small text columns, an unobtrusive background, a large font-size, and attention-grabbing headlines. This could have forced users of the developing news story application to invest more cognitive effort in the reading process and, therefore, left them with less cognitive effort to process detailed factual information. Although inherent to the testing of existing real-life news applications, we advise future research to more rigorously take account of differences in lay-out features when comparing learning from different news designs. In addition, the observed difference between effects of information structure on factual recall and news comprehension illustrates the necessity to differentiate between conceptually distinguished memory processes and learning outcomes when studying learning from the news.

Although the mean scores for our attention measures (i.e., eye fixation time and number of articles read about the target story) were higher in the developing news story condition than in the linear news structure condition, these differences were not statistically significant. A possible explanation for this finding is that the power of our independent t-tests for eye fixation time (.162) and number of articles read (.318) were low, increasing the chances of missing a small effect of the developing news story structure on news attention. In addition, participants in the developing news story condition were only once a day exposed to the developing news stories. Hence, the potential of the developing news structure for increasing attention for the news stories was not fully tapped. As Van Cauwenberge et al. (2013) have indicated, mobile news users who follow news as developing stories check the news multiple times a day to stay on top of new developments. Therefore, we advise future research to test tablet news structures in a more natural, real-life setting and across a longer period of time.

The study has some other notable limitations. Foremost, because the analyses were run on only 21 participants, our tests did not achieve sufficient power to detect small effect sizes, running the risk of missing an effect if one genuinely existed. Because we had only one eye-tracker at our disposal, it was not possible to test more participants a day. Furthermore, the use of natural news materials did not allow us to recruit more participants afterwards. In addition, the biased nature of our study sample, consisting of students only, limits the

generalization of our findings. For these reasons, the results of this study must be considered with caution.

As a final note, what may news producers take home from this study? First of all, the results from this study indicate that a news structure that takes into account (*a*) how news stories are consumed and experienced by users, (*b*) the functional attributes of a medium, and (*c*) the cognitive information processes that underlie effective learning may be successful for facilitating meaningful learning from the news. This finding is of great importance to news producers, as news comprehension is a prerequisite for enhancing attention for news, especially among those that are less inclined to follow the news regularly (e.g., Couldry, Livingstone, and Markham 2010). By providing a news structure that stimulates and facilitates cognitive processing of news, hence increasing overall news comprehension among users, news producers might, in the long run, be more successful in attracting an audience for news. In addition, with news being increasingly made available on demand and customized to the tastes and preferences of users, news consumption is nowadays to a large part centered around notions of convenience. For example, Tremayne, Schmitz Weiss, and Calmon Alves (2007) observed that over the last decade news production gradually shifted from a product towards a service-oriented approach. Indeed, when tablet news users are asked what they like about the tablet, "better access to news", "ease of use", "ability to track topics" are most mentioned (Pew Research Center 2011b). These findings suggest that news producers could strengthen ties with news audiences by exploring new ways of presenting news that are tailored to the specific news consumption patterns and needs of an increasingly mobile news audience. This study suggested one way to do so.

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